IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Applicant(s): Boer et al.
Case: Boer 7-3-2-3
Serial No.: 10/562,618
Filing Date: May 15, 2006
Group: 2617
Examiner: Fred A. Casca

Title: Method and Apparatus for Communicating Symbols in a Multiple Input Multiple Output Communication System Using Interleaved Subcarriers Across a Plurality of Antennas

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APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants hereby appeal the final rejection dated February 4, 2010, of claims 1 through 34 of the above-identified patent application.

REAL PARTY IN INTEREST

The present application is assigned to Agere Systems Inc., as evidenced by an assignment recorded on May 10, 2006 in the United States Patent and Trademark Office at Reel 017607, Frame 0529. The assignee, Agere Systems Inc., is the real party in interest.

RELATED APPEALS AND INTERFERENCES

An Appeal Brief was submitted on August 6, 2009 for related United States Patent Application Serial No. 10/562,619.

STATUS OF CLAIMS

The present application was filed on May 15, 2006 with claims 1 through 34. Claims 1 through 34 are presently pending in the above-identified patent application. Claims 1-7, 10-16, and 21-25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. (United States Publication No. 2004/0022174) in view of Sandell (United States Publication No. 2004/0131011), claims 8, 17, 18, 20, and 26-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of Joo (United States Publication No. 2004/0208253), and claims 9 and 19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of well know prior art (MPEP 2144.03).

Claims 1, 2, 4, 7, 8, 10, 4, 17, 20-22, 25, 26, 29, and 31-34 are being appealed.

STATUS OF AMENDMENTS

There have been no amendments filed subsequent to the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 is directed to a method for transmitting one or more symbols in a multiple antenna wireless communication system (FIG. 1: 100), the method comprising the step of:

diagonally loading subcarriers from the one or more symbols across a plurality of antennas (FIG. 1: 110) in the multiple antenna wireless communication system (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Claims 2 and 22 requires wherein the one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from the single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Claim 4 requires wherein the one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from the single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna (page 5, lines 23-26).

Claim 7 requires inserting one or more additional subcarriers in at least one of the plurality of symbols (FIGS. 5 and 6; page 6, line 16, to page 7, line 28; and page 8, lines 4-27).

Claim 8 requires where the one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by the diagonal loading is surrounded by subcarriers that are not nulled (FIGS. 5 and 6; page 6, line 16, to page 7, line 28; and page 8, lines 4-27).

Claims 10 and 20 require wherein a reduced number of subcarriers are inserted in the at least one of the plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier (FIG. 6; page 8, lines 4-27).

Claims 14 and 25 require diagonally loading a remainder of a header of a packet across the logically adjacent antennas; and diagonally loading data sequences of the packet across the logically adjacent antennas (page 9, lines 16-23).

Independent claim 17 is directed to a method for generating a plurality of long training symbols in a multiple antenna wireless communication system (FIG. 1: 100; page 4, line 28, to page 5, line 26), the method comprising the step of:

diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in the multiple antenna wireless communication system (FIGS. 4-7; page 5, line 17, to page 6, line 4);

nulling subcarriers in the plurality of long training symbols that are not diagonally loaded (FIGS. 4-7; page 5, line 17, to page 6, line 4); and

inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of the nulled subcarrier (FIGS. 5 and 6; page 6, line 16, to page 7, line 28; and page 8, lines 4-27).

Independent claim 21 is directed to a transmitter in a multiple antenna wireless communication system (FIG. 1: 100), comprising:

a plurality of transmit antennas (FIG. 1: 110), wherein subcarriers of one or more symbols are diagonally loaded across logically adjacent antennas (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Independent claim 26 is directed to a method for transmitting one or more symbols in a multiple antenna wireless communication system (FIG. 1: 100), the method comprising the step of:

transmitting subcarriers from the one or more symbols using a plurality of antennas (FIG. 1: 110) in the multiple antenna wireless communication system such that each of the subcarriers are active on only one of the plurality of antennas at a given time (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Independent claim 29 is directed to a transmitter in a multiple antenna wireless communication system (FIG. 1: 100), comprising:

a plurality of transmit antennas (FIG. 1: 110) for transmitting subcarriers from one or more symbols such that each of the subcarriers are active on only one of the plurality of antennas at a given time (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Independent claim 31 is directed to a method for receiving one or more symbols on at least one receive antenna (FIG. 1: 115) transmitted by a transmitter having a plurality of transmit antennas (FIG. 1: 110) in a multiple antenna wireless communication system (FIG. 1: 100; FIG. 12; page 14, lines 11-20), the method comprising the step of:

aggregating subcarriers from the one or more symbols that were transmitted such that each of the subcarriers are active on only one of the plurality of antennas at a given time (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Claims 32 and 34 require wherein said subcarriers are diagonally loaded across said plurality of antennas (FIGS. 4-7; page 5, line 17, to page 6, line 4).

Independent claim 33 is directed to a receiver (FIG. 12: 1200) in a multiple antenna wireless communication system (FIG. 1: 100) having at least one transmitter having a plurality of transmit antennas (FIG. 1: 110), comprising:

at least one receive antenna (FIG. 1: 115); and

an aggregator for aggregating subcarriers from one or more symbols that were transmitted such that each of the subcarriers are active on only one of the plurality of antennas (FIG. 1: 110) at a given time (FIGS. 4-7; page 5, line 17, to page 6, line 4; FIG. 12; page 14, line 18, to page 15, line 20).

STATEMENT OF GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-7, 10-16, and 21-25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell, claims 8, 17, 18, 20, and 26-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in

view of Joo, and claims 9 and 19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of well know prior art (MPEP 2144.03).

ARGUMENT

Independent claims 1, 17, 21, 26, 29, and 31-34

Independent claims 1 and 21 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell, and claims 17, 26, 29, and 31-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of Joo. Regarding claim 1, the Examiner asserts that Li discloses diagonally loading subcarriers from said one or more symbols (paragraphs 46 and 4; and FIGS. 1-4).

Appellants note that, in the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, long-training symbols X 355a and X 365a are transmitted during the long-training period 320. Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. Each element X(k) of X is carried by its corresponding kth sub-carrier. It should be appreciated that X is inverse Fourier transformed to a time domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.

Li teaches the transmission of short-training symbols and long-training symbols; Li makes *no* reference to diagonal loading. Furthermore, paragraph [0041] of Sandell is directed to *a diagonal channel matrix to estimate a channel impulse response;* Sandell does *not* disclose or suggest *diagonally loading subcarriers*. Independent claims 1 and 21 require *diagonally loading subcarriers from said one or more symbols across a plurality of antennas* in said multiple antenna wireless communication system. Independent claim 17 requires *diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas* in said multiple antenna wireless communication system; nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier. Independent claims 26 and 29 require transmitting subcarriers from said one or more symbols using a plurality of antennas in

said multiple antenna wireless communication system *such that each of said subcarriers are active on only one of said plurality of antennas at a given time.* Independent claims 31 and 33 require aggregating subcarriers from said one or more symbols that were transmitted such that *each of said subcarriers are active on only one of said plurality of antennas at a given time.* Claims 32 and 34 require *wherein said subcarriers are diagonally loaded across said plurality of antennas.*

In the Response to Arguments section of the final Office Action, the Examiner asserts that the diagonal loading of symbols is inherent in OFDM channels and the diagonal loading of symbols across multiple antennas is inherent in a MIMO-OFDM channel. In evidence of the allegation that an OFDM channel loads data symbols diagonally, the Examiner asserts that chapter 3 of Tse, particularly section 3.4.4, teaches that smaller portions of the input data are interleaved across the transmit and receive antennas. The Examiner asserts that the inherent interleaving function of OFDM is equivalent to diagonal loading of the claimed limitation.

Appellants note that Tse describes the cited interleaving function in section 3.2 and, in particular, FIG. 3.5. As shown in FIG. 3.5, each portion of each codeword x_0-x_3 is interleaved such that each of the four portions of codeword x_0 reside in each of the first locations of the four interleaved codewords. Similarly, each of the four portions of codeword x_1 reside in each of the second locations of the four interleaved codewords, each of the four portions of codeword x_2 reside in each of the third locations of the four interleaved codewords, and each of the fourth portions of codeword x_3 reside in each of the last locations of the four interleaved codewords. Thus, while the codewords are interleaved, they are *not diagonally loaded*; diagonally loading would result in a portion of each codeword residing in a different location in each interleaved codeword, i.e., for example, a first portion of x_1 would reside in a *first* location of a first interleaved codeword, a second portion of x_1 would reside in a *second* location of a second interleaved codeword, and so on. (See, FIG. 4 and the associated text of the present disclosure.)

In the Response to Arguments section of the final Office Action, the Examiner further refers applicant to the reference Terable et al., particularly paragraph [0119], in providing evidence that interleaving (alleged to be equivalent to diagonal loading) is inherent in OFDM.

In the text cited by the Examiner, Terable teaches:

> [0119]The interleaver 132b conducts interleaving inherent to the OFDM transmitter T0, for the encoding result of the channel encoder 131 to make the

data signal have the orthogonality to the other OFDM transmitters T1 and T2. The scheduling unit 110 outputs the inherent interleaving pattern information to the subcarrier allocating unit 160 to notify the OFDM receiver R0 of the information.

As argued above, while diagonal loading is a type of interleaving, interleaving is *not* equivalent to diagonal loading. Terable does *not* disclose or suggest *diagonal loading.*

In the Response to Arguments section of the final Office Action, the Examiner further asserts that Sandell teaches a MIMO-OFDM system that displays multiple streams (sub-carriers) found between multiple input and multiple output antennas (paragraphs [0098]-[0108] and FIG. 5).

Appellants note that, in the text cited by the Examiner, Sandell teaches, for example, a channel parameter estimator 600. Sandell does *not* disclose or suggest *diagonal loading.* Furthermore, the Examiner's assertion that multiple streams are equivalent to subcarriers is *not* correct. In a MIMO-OFDM system, the streams are spatially-multiplexed data streams, each consisting of multiple subcarriers, i.e., spatial data streams and OFDM subcarriers are two different entities, as would be apparent to a person of ordinary skill in the art.

In the Response to Arguments section of the final Office Action, the Examiner further asserts that, since the D matrix is diagonal, where each diagonal element of the matrix is a sub-carrier, the input data are loaded into the sub-carriers diagonally.

Appellants note that each of the "diagonal" elements in the D matrix corresponds to a spatially-multiplexed data stream and does *not* indicate a diagonal loading of subcarriers, i.e., with SVD, the input data are *not* loaded onto the subcarriers diagonally. SVD has *no* relationship to diagonally loaded subcarriers as all subcarriers for each spatial substream are loaded into the same element of D, as would be apparent to a person of ordinary skill in the art.

Thus, Li et al., Sandell, and Joo, alone or in combination, do not disclose or suggest diagonally loading subcarriers from said one or more symbols across a plurality of antennas in said multiple antenna wireless communication system, as required by independent claims 1 and 21, do not disclose or suggest diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in said multiple antenna wireless communication system; nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier, as required by independent claim 17, do not disclose or suggest

transmitting subcarriers from said one or more symbols using a plurality of antennas in said multiple antenna wireless communication system such that each of said subcarriers are active on only one of said plurality of antennas at a given time, as required by independent claims 26 and 29, do not disclose or suggest aggregating subcarriers from said one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time, as required by independent claims 31 and 33, and do not disclose or suggest wherein said subcarriers are diagonally loaded across said plurality of antennas, as required by claims 32 and 34.

Claims 2 and 22

Claims 2 and 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell. In particular, the Examiner asserts that Li/Sandell discloses wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna (Li: paragraphs 4 and 46; FIGS. 1-4).

In the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, long-training symbols X 355a and X 365a are transmitted during the long-training period 320. Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. *Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. Each element X(k) of X is carried by its corresponding kth sub-carrier.* It should be appreciated that X is inverse Fourier transformed to a time domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.
> (Paragraph [0046]; emphasis added.)

Li teaches that "*each element X(k) of X is carried by its corresponding kth sub-carrier*"; Li does *not* disclose or suggest *wherein each subsequent subcarrier from a single-antenna long training symbol is positioned in a long training symbol for a* logically adjacent *antenna.* Claims 2 and 22 requires *wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from*

said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.

Thus, Li et al. and Sandell, alone or in combination, do not disclose or suggest wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna, as required by claims 2 and 22.

Claim 4

Claim 4 was rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell. Regarding claim 4, the Examiner asserts that Li/Sandell discloses wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna (Li: paragraphs 4 and 46; FIGS. 1-4).

In the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, *the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, long-training symbols X 355a and X 365a are transmitted during the long-training period 320.* Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. *Each element X(k) of X is carried by its corresponding kth sub-carrier.* It should be appreciated that X is inverse Fourier transformed to a time domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.
> (Paragraph [0046]; emphasis added.)

Li teaches that "*each element X(k) of X is carried by its corresponding kth sub-carrier*"; Li does *not* disclose or suggest *wherein <u>each subsequent subcarrier</u> from a single-antenna short training symbol is <u>positioned in a short training symbol</u> for a <u>logically adjacent</u> antenna.* Claim 4 requires *wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna.*

Thus, Li et al. and Sandell, alone or in combination, do not disclose or suggest wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna, as required by claim 4.

<u>Claims 7</u>

Claim 7 was rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell. Regarding claim 7, the Examiner asserts that Li/Sandell discloses inserting one or more additional subcarriers in at least one of said plurality of symbols (Li: paragraphs 4 and 46; FIGS. 1-4; inserting additional subcarriers is inherent in OFDM).

In the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, long-training symbols X 355a and X 365a are transmitted during the long-training period 320. Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. *Each element X(k) of X is carried by its corresponding kth sub-carrier*. It should be appreciated that X is inverse Fourier transformed to a time domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.
> (Paragraph [0046]; emphasis added.)

Li teaches that "*each element X(k) of X is carried by its corresponding kth sub-carrier*"; Li does *not* disclose or suggest *<u>inserting one or more additional</u> subcarriers in at least one of a plurality of symbols*. Claim 7 requires inserting one or more additional subcarriers in at least one of said plurality of symbols.

Thus, Li et al. and Sandell, alone or in combination, do not disclose or suggest inserting one or more additional subcarriers in at least one of said plurality of symbols, as required by claim 7.

<u>Claim 8</u>

Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of Joo. In particular, the Examiner asserts that Joo

discloses nulling subcarriers that are not diagonally loaded and inserting non-nulled subcarriers adjacent to nulled subcarriers (abstract and paragraph 25).

In the text cited by the Examiner, Joo teaches that "*a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers*" (paragraph [0025]); Joo does *not* disclose or suggest where one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by diagonal loading is surrounded by subcarriers that are not nulled. Claim 8 requires where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled.

Thus, Li et al., Sandell, and Joo, alone or in combination, do not disclose or suggest where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled, as required by claim 8.

Claims 10 and 20

Claim 10 was rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and claim 20 was rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell and further in view of Joo. Regarding claim 10, the Examiner asserts that Li/Sandell discloses wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier (Li: paragraphs 4 and 46; FIGS. 1-4; Sandell paragraph 41). In the rejection of claim 20, the Examiner cited paragraph [0025] of Joo.

In the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, *long-training symbols X 355a and X 365a are transmitted during the long-training period 320.* Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. *Each element X(k) of X is carried by its corresponding kth sub-carrier.* It should be appreciated that X is inverse Fourier transformed to a time

> domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.
> (Paragraph [0046]; emphasis added.)

Li teaches that "*long-training symbols X 355a and X 365a are transmitted during the long-training period 320*" and that "*each element X(k) of X is carried by its corresponding kth sub-carrier*"; Li does *not* disclose or suggest *wherein a reduced number of subcarriers are* *<u>inserted</u>* *in at least one of a plurality of long training symbols* and *wherein a first long training symbol and a second long training symbol are* ***<u>interchanged</u>*** *<u>to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier</u>*. Claims 10 and 20 require *wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.*

Also, in the text cited by the Examiner, Joo teaches that "*a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers*" (paragraph [0025]); Joo does *not* disclose or suggest *wherein a reduced number of subcarriers are* *<u>inserted</u>* *in at least one of a plurality of long training symbols* and *wherein a first long training symbol and a second long training symbol are* ***<u>interchanged</u>*** *<u>to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier</u>*.

Thus, Li et al., Sandell, and Joo, alone or in combination, do not disclose or suggest wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier, as required by claims 10 and 20.

<u>Claims 14 and 25</u>

Claims 14 and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Li et al. in view of Sandell. Regarding claim 14, the Examiner asserts that Li/Sandell discloses diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent

antennas (Li: paragraphs 4 and 46; FIGS. 1-4; Sandell paragraph 41).

In the text cited by the Examiner, Li teaches:

> [0046] Thus, as shown in FIG. 3A, the first transmitter transmits symbols during the short-training period 310 in accordance with the IEEE 5 GHz standard. Once the short-training symbols have been transmitted, *long-training symbols X 355a and X 365a are transmitted during the long-training period 320*. Here, the capital symbol X denotes a set of the frequency domain quantities in an orthogonal frequency division multiplexing (OFDM) system. Thus, X can be viewed as a vector containing N elements, where N is the number of sub-carriers in the OFDM system. *Each element X(k) of X is carried by its corresponding kth sub-carrier*. It should be appreciated that X is inverse Fourier transformed to a time domain signal, added with a cyclic prefix, and converted to a radio-frequency (RF) analog signal by an RF module prior to being radiated from a transmit antenna.
> (Paragraph [0046]; emphasis added.)

Li teaches that "*each element X(k) of X is carried by its corresponding kth sub-carrier*"; Li does *not* disclose or suggest *diagonally loading a remainder of a header of a packet across logically adjacent antennas*; and does *not* disclose or suggest *diagonally loading data sequences of a packet across logically adjacent antennas*. Claims 14 and 25 require diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas.

Thus, Li et al. and Sandell, alone or in combination, do not disclose or suggest diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas, as required by claims 14 and 25.

<u>Conclusion</u>

The rejections of the cited claims under section 103 in view of Li et al., Sandell, Joo, and well know prior art, alone or in any combination, are therefore believed to be improper and should be withdrawn. The remaining rejected dependent claims are believed allowable for at least the reasons identified above with respect to the independent claims.

The attention of the Examiner and the Appeal Board to this matter is appreciated.

Respectfully,

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Date: August 30, 2010

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CLAIMS APPENDIX

1. A method for transmitting one or more symbols in a multiple antenna wireless communication system, said method comprising the step of:

diagonally loading subcarriers from said one or more symbols across a plurality of antennas in said multiple antenna wireless communication system.

2. The method of claim 1, wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.

3. The method of claim 2, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol.

4. The method of claim 1, wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna.

5. The method of claim 4, wherein said single-antenna short training symbol is an 802.11 a/g short training symbol.

6. The method of claim 1, wherein said multiple antenna wireless communication system is a MIMO-OFDM system.

7. The method of claim 1, further comprising the step of inserting one or more additional subcarriers in at least one of said plurality of symbols.

8. The method of claim 7, where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by

subcarriers that are not nulled.

9. The method of claim 7, where said one or more additional subcarriers allow nulled subcarriers to be estimated using an interpolation-based channel estimation technique.

10. The method of claim 2, wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.

11. The method of claim 1, wherein said one or more symbols are a SIGNAL-field symbol.

12. The method of claim 11, wherein said SIGNAL-field symbol includes a system type indicator.

13. The method of claim 2, wherein a number of said long training symbols is a function of the number of transmitters.

14. The method of claim 1, further comprising the steps of:

diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and

diagonally loading data sequences of said packet across said logically adjacent antennas.

15. The method of claim 1, wherein said plurality of antennas are logically adjacent.

16. The method of claim 1, whereby a lower order receiver can interpret said transmitted diagonally loaded symbols as a normal OFDM frame.

17. A method for generating a plurality of long training symbols in a multiple antenna wireless communication system, said method comprising the step of:

diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in said multiple antenna wireless communication system;

nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and

inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier.

18. The method of claim 17, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol.

19. The method of claim 17, where said at least one additional subcarrier allows nulled subcarriers to be estimated using an interpolation-based channel estimation technique.

20. The method of claim 17, wherein a reduced number of subcarriers are inserted in at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.

21. A transmitter in a multiple antenna wireless communication system, comprising:

a plurality of transmit antennas, wherein subcarriers of one or more symbols are diagonally loaded across logically adjacent antennas.

22. The transmitter of claim 21, wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.

23. The transmitter of claim 21, wherein said multiple antenna wireless communication system is a MIMO-OFDM system.

24. The transmitter of claim 21, wherein said one or more symbols are a SIGNAL-field symbol.

25. The transmitter of claim 21, wherein:

a remainder of a header of a packet are diagonally loaded across said logically adjacent antennas; and

data sequences of said packet are diagonally loaded across said logically adjacent antennas.

26. A method for transmitting one or more symbols in a multiple antenna wireless communication system, said method comprising the step of:

transmitting subcarriers from said one or more symbols using a plurality of antennas in said multiple antenna wireless communication system such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

27. The method of claim 26, wherein said transmitting step further comprises the step of diagonally loading said subcarriers across said plurality of antennas.

28. The method of claim 26, wherein said plurality of antennas are logically adjacent.

29. A transmitter in a multiple antenna wireless communication system, comprising:

a plurality of transmit antennas for transmitting subcarriers from one or more symbols such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

30. The transmitter of claim 29, wherein said subcarriers are diagonally loaded across said plurality of antennas.

31. A method for receiving one or more symbols on at least one receive antenna transmitted by a transmitter having a plurality of transmit antennas in a multiple antenna wireless communication system, said method comprising the step of:

aggregating subcarriers from said one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

32. The method of claim 31, wherein said subcarriers are diagonally loaded across said plurality of antennas.

33. A receiver in a multiple antenna wireless communication system having at least one transmitter having a plurality of transmit antennas, comprising:

at least one receive antenna; and

an aggregator for aggregating subcarriers from one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

34. The receiver of claim 33, wherein said subcarriers are diagonally loaded across said plurality of antennas.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to § 1.130, 1.131, or 1.132 or entered by the Examiner and relied upon by appellant.

RELATED PROCEEDINGS APPENDIX

There are no known decisions rendered by a court or the Board in any proceeding identified pursuant to paragraph (c)(1)(ii) of 37 CFR 41.37.